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title: "QMM\_Assignment4"  
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Q2)

1) What is the minimum cost of providing oil to the refineries? Which wells are used to capacity in the optimal schedule?

Supply is 276 TBD and the demand is 274 TBD. So, the demand is not equal to supply.

As given in the problem, the minimum objective function is formulated below:

$$\begin{aligned} Z_{\min} = & 1.52 X_{1A} + 1.60 X_{1B} + 1.40 X_{1C} + 1.70 X_{2A} + 1.63 X_{2B} + 1.55 X_{2C} + \\ & 1.45 X_{3A} + \\ & 1.57 X_{3B} + 1.30 X_{3C} + 5.15 X_{A1} + 5.12 X_{B1} + 5.32 X_{C1} + 5.69 X_{A2} + 5.47 \\ & X_{B2} + 6.16 X_{C2} + \\ & 6.13 X_{A3} + 6.05 X_{B3} + 6.25 X_{C3} + 5.63 X_{A4} + 6.12 X_{B4} + 6.17 X_{C4} + 5.80 \\ & X_{A5} + 5.71 X_{B5} + \\ & 5.87 X_{C5} \end{aligned}$$

Constraints:

Supply Constraints

$$\begin{aligned} X_{1A} + X_{1B} + X_{1C} &= 93 \\ X_{2A} + X_{2B} + X_{2C} &= 88 \\ X_{3A} + X_{3B} + X_{3C} &= 95 \end{aligned}$$

Demand Constraints

$$\begin{aligned} X_{A1} + X_{B1} + X_{C1} &= 30 \\ X_{A2} + X_{B2} + X_{C2} &= 57 \\ X_{A3} + X_{B3} + X_{C3} &= 48 \\ X_{A4} + X_{B4} + X_{C4} &= 91 \\ X_{A5} + X_{B5} + X_{C5} &= 48 \end{aligned}$$

Constraints from pumps to refinery

$$\begin{aligned} X_{1A} + X_{2A} + X_{3A} &= X_{A1} + X_{A2} + X_{A3} + X_{A4} + X_{A5} \\ X_{1B} + X_{2B} + X_{3B} &= X_{B1} + X_{B2} + X_{B3} + X_{B4} + X_{B5} \\ X_{1C} + X_{2C} + X_{3C} &= X_{C1} + X_{C2} + X_{C3} + X_{C4} + X_{C5} \end{aligned}$$

Where,  $X_{ij} \geq 0$ :  $i$ (pumps) = (A, B, C),  $j$ = 1,2,3(wells), 1:5(refineries)

Using Ipsolve the optimal solution is 1932.3

Well 3 has used to the capacity in the optimal schedule.

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```{r}
library(lpSolveAPI)
lprec<-make.lp(0,24)
lp.control(lprec,sense='min')
set.objfn(lprec,c(1.52,1.60,1.40,1.70,1.63,1.55,1.45,1.57,1.30,5.15,5.12,
5.32,5.69,5.47,6.16,6.13,6.05,6.25,5.63,6.12,6.17,5.80,5.71,5.87))
add.constraint(lprec,c(1,1,1),"=",93,indices = c(1,2,3))
add.constraint(lprec,c(1,1,1),"=",88,indices = c(4,5,6))
add.constraint(lprec,c(1,1,1),"=",95,indices = c(7,8,9))
add.constraint(lprec,c(1,1,1),"=",30,indices = c(10,11,12))
add.constraint(lprec,c(1,1,1),"=",57,indices = c(13,14,15))
add.constraint(lprec,c(1,1,1),"=",48,indices = c(16,17,18))
add.constraint(lprec,c(1,1,1),"=",91,indices = c(19,20,21))
add.constraint(lprec,c(1,1,1),"=",48,indices = c(22,23,24))
add.constraint(lprec,c(rep(1,3),rep(-
1,6)),"=",0,indices=c(1,4,7,10,13,16,19,22,25))
add.constraint(lprec,c(rep(1,3),rep(-
1,6)),"=",0,indices=c(2,5,8,11,14,17,20,23,26))
add.constraint(lprec,c(rep(1,3),rep(-
1,6)),"=",0,indices=c(3,6,9,12,15,18,21,24,27))
solve(lprec)
get.objective(lprec)
get.constraints(lprec)
get.variables(lprec)
```
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